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Chapter 2
Safety Fundamentals
for Bridge Inspectors

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Topic 2.5 Methods of Access

2.5.1 Introduction

The two primary methods of gaining access to hard to reach areas of a bridge are access equipment and access vehicles. Common access equipment includes ladders, rigging, and scaffolds, while common access vehicles include manlifts, bucket trucks, and under bridge inspection vehicles. In most cases, using a manlift or bucket truck will be less time consuming than using a ladder or rigging to inspect a structure. The time saved, however, is normally offset by the higher costs associated with operating access vehicles.

2.5.2 Types of Access Equipment

The purpose of access equipment is to position the inspector close enough to the bridge component so that a "hands-on" inspection can be performed. The following are some of the most common forms of access equipment used in bridge inspection.

Ladders

Ladders are used for inspecting the underside of a bridge or for inspecting substructure units. However, a ladder is used only for those portions of the bridge that can be reached safely, without undue leaning or reaching. The proper length of the ladder is determined by using it at a four vertical to one horizontal angle. When set up at the proper angle (1 horizontal to 4 vertical), the inspector is able to reach out horizontally, grasp the rung while keeping his or her feet at the base of the ladder (see Figure 2.5.1).

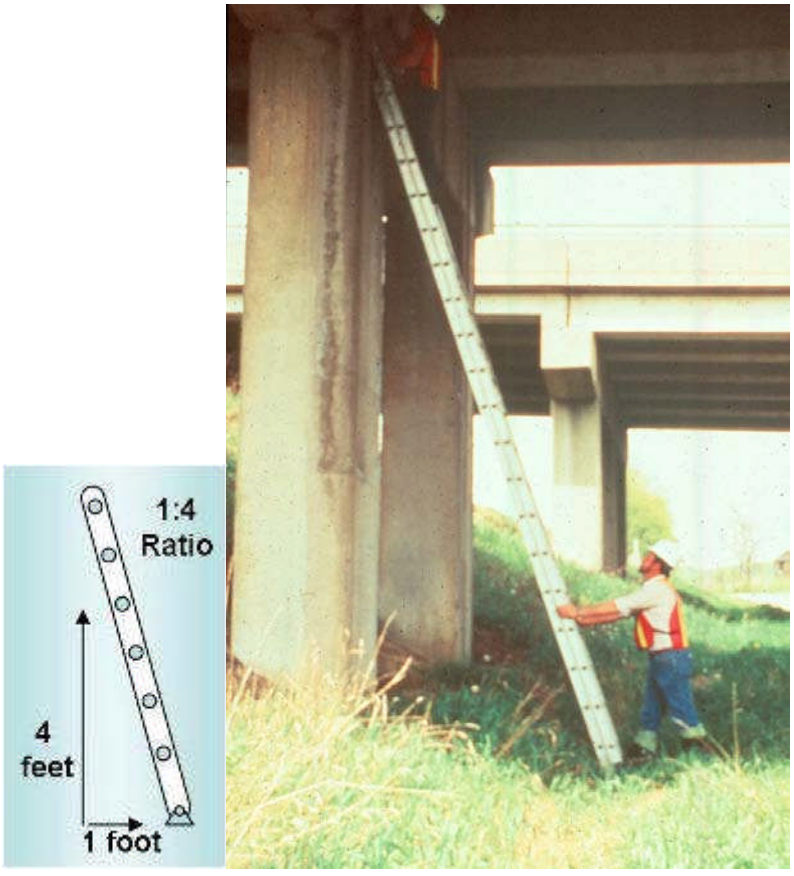

Figure 2.5.1 Inspectors using a Ladder with the Proper 1H to 4V Ratio

Ladders are also used to climb down to access members of the bridge. The hook-ladder, as it is commonly referred to, is fastened securely to the bridge framing (see Figure 2.5.2).

Figure 2.5.2 Inspector using a Hook-ladder

When using a hook-ladder, the inspector is tied off to a separate safety line, independent of the ladder.

Rigging

Rigging of a structure consists of cables and platforms. Rigging is used to gain access to floor systems and main load-carrying members in areas where access by other means is not feasible or where special inspection procedures are required (e.g., NDE of pins). Rigging is often used when ladders or other access equipment cannot reach a given location (see Figures 2.5.3 and 2.5.4). Rigging is a good choice for a load-posted bridge that does not have the capacity to support an inspection vehicle.

Rigging does not interfere with traffic on the bridge and can be used in high traffic situations where lane closures are intolerable, and on toll facilities to avoid loss of revenue. Rigging may not be an option if there is not enough clearance to avoid interfering with passing features below the bridge.

Figure 2.5.3 Rigging for Substructure Inspection

Figure 2.5.4 Rigging for Superstructure Inspection

Scaffolds

Scaffolds provide an efficient access alternative for structures that are less than 40 feet high and over level ground with little or no traffic nearby (see Figure 2.5.5). The Occupational Safety and Health Administration (OSHA) has specific requirements when working on scaffolding. Scaffolds may take longer to set up than it takes to inspect the bridge. For this reason, scaffolding is not normally used for bridge inspections.

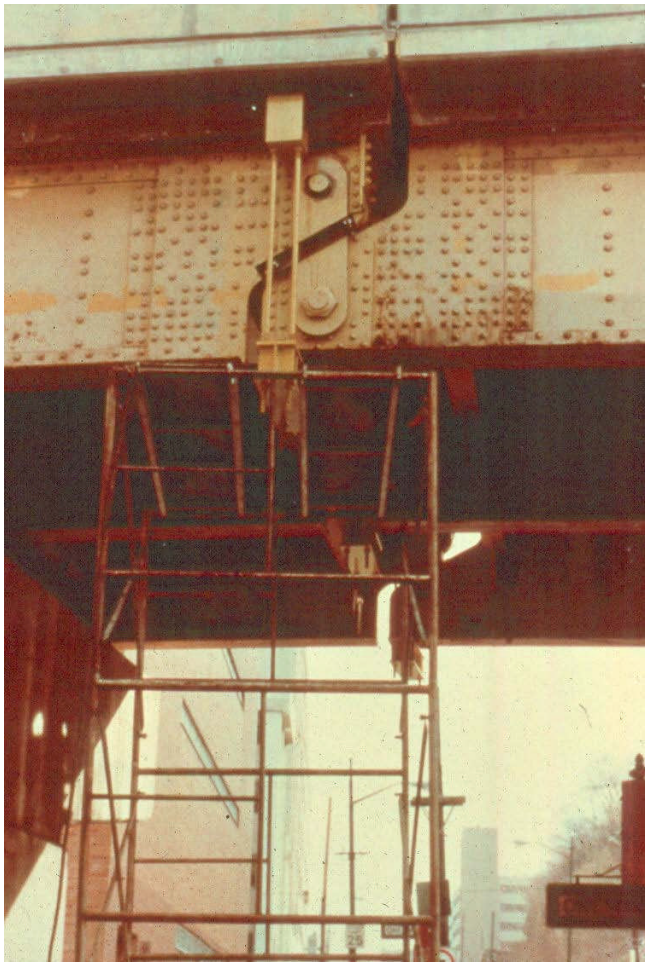

Figure 2.5.5 Scaffold

Boats or Barges

A boat or barge may be needed to gain access to structures over water. A boat can be used for inspection, as well as providing access to areas for taking photographs. Also, a safety boat is required when performing an inspection over water (see Figure 2.5.6).

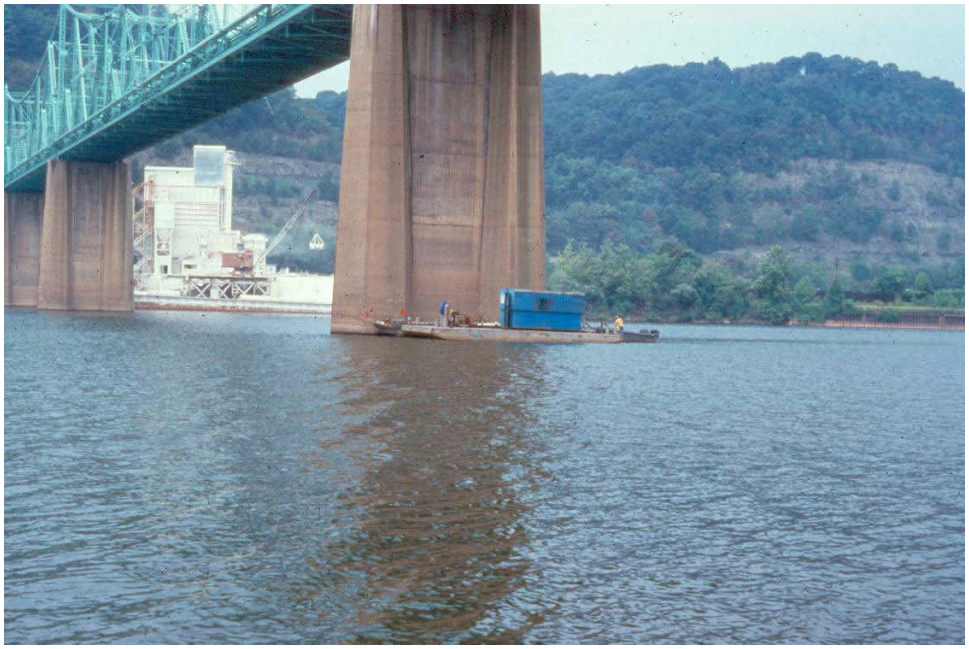

Figure 2.5.6 Inspection Operations from a Barge

A barge may also be used in combination with other access equipment or vehicles to perform an inspection. The barge may be temporarily anchored in place to provide a platform for a manlift or mobilization for underwater inspections.

Climbers

Climbers are mobile inspection platforms or cages that "climb" steel cables or truss members (see Figure 2.5.7). They are well suited for the inspection of high piers and other long vertical faces of bridge members.

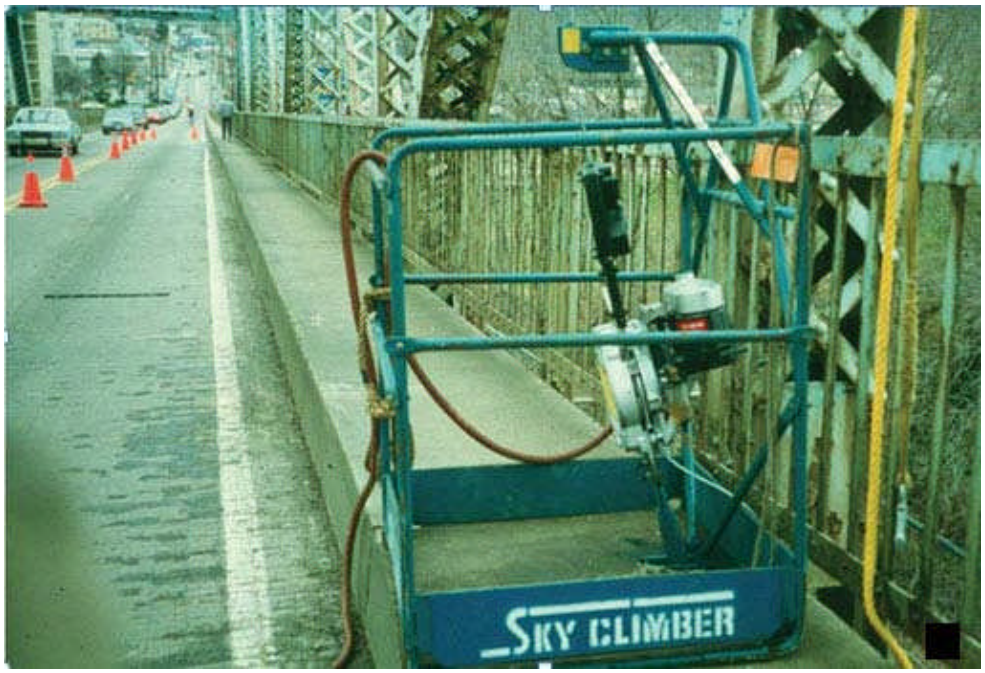

Figure 2.5.7 Climber

Floats

A float is a wood plank work platform hung by ropes (see Figure 2.5.8). Floats are generally used for access in situations where the inspector will be at a particular location for a relatively long period of time.

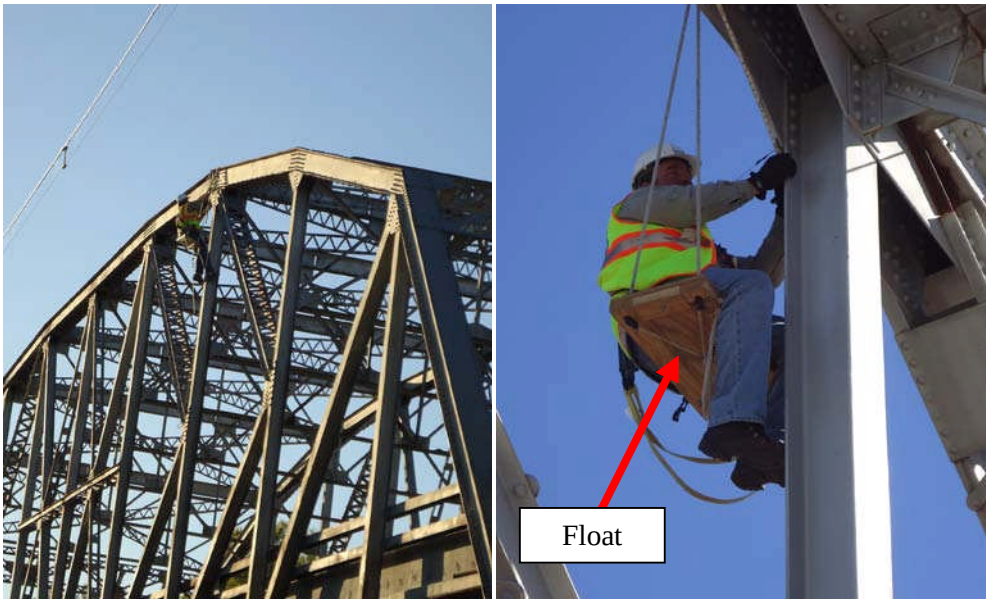

Figure 2.5.8 Inspector Using Float

Bosun (or Boatswain) Chairs / Rappelling

Bosun (or boatswain) chairs are suspended with a rope and can carry one inspector at a time. They can be raised and lowered with block and tackle devices. Rappelling is a similar access method to the Bosun chair but utilizes different equipment and techniques (see Figure 2.5.9). However, both methods require the use of independent safety lines.

Figure 2.5.9 Inspector Rappelling Substructure Unit

Free Climbing

On structures, where other methods of access are not practical, inspectors climb on the bridge members to gain access (see Figure 2.5.10). Safety awareness is of the utmost importance when utilizing this technique. When using this method, the inspector is tied off to the bridge using an independent safety harness and lanyard.

Figure 2.5.10 Climbing

Permanent Inspection Structures

On some structures, inspection access is included in the design and construction of the bridge. These are typically found on long span structures or more complex designs. Although these inspection platforms only give access to a limited portion of the bridge, they do provide a safe and effective means for the inspector to work. The following are some examples of permanent inspection structures.

Catwalks

A catwalk is an inspection platform typically running parallel to the girders under the superstructure (see Figure 2.5.11). Catwalks can be used to inspect parts of the deck, superstructure and some portions of the substructure. The range of inspection area is limited to those locations near the catwalk.

Figure 2.5.11 Catwalk

Traveler

A traveler is another permanent inspection platform similar to a catwalk except that it is movable. A traveler platform is typically perpendicular to the girders and the platform runs on a rail system between substructure elements (see Figure 2.5.12). Having the platform perpendicular to the girders allows the inspectors a wider range of movement and enables them to see more of the superstructure elements.

Figure 2.5.12 Traveler Platform

Handrails

Handrails are also used to aid an inspector. Handrails can be used in a number of different locations on the bridge. On the main suspension cables, on top of the pier caps, and on the girder web are just a few locations where handrails may be built (see Figures 2.5.13 and 2.5.14). Handrails are typically provided to assist the inspector when free climbing on the bridge and give the inspector a place to secure their lanyard and safety harness.

Figure 2.5.13 Handrail on Girder Bridge

Figure 2.5.14 Handrail on Suspension Bridge

Inspection Robots

Currently, efforts are being made for robots to be used for inspection purposes. Though still early in the development stage, robots may prove to be an important addition to the inspector's access equipment. Although a robot can never replace a qualified inspector, it can provide information that may not be visible to the human eye. A robot equipped with sonar capabilities can detect internal flaws in bridge members. Also, a robot can be used in situations that are too difficult to reach or extremely dangerous for a human.

2.5.3 Types of Access Vehicles

There are many types of vehicles available to assist the inspector in gaining access for "hands-on" inspection of bridge members. The following are some of the most common types of access vehicles used in bridge inspection.

Manlift

A manlift is a vehicle with a platform or bucket capable of holding one or more inspectors. The platform is attached to a hydraulic boom that is mounted on a carriage. An inspector "drives" the carriage using controls in the platform. This type of vehicle is usually not licensed for use on highways. However, some manlifts are nimble and can operate on a variety of terrains. Although four wheel drive models are available, manlifts are limited to use on fairly level terrain. Manlifts come in a number of different sizes with vertical reaches ranging from 40 feet to over 170 feet (see Figure 2.5.15).

Figure 2.5.15 Manlift

Scissors Lift

Scissor lifts may be used for bridge inspections with low clearance between the bridge and underpassing roadway. Scissor lifts have a typical maximum vertical reach of 20 feet. These lifts are designed for use on relatively level ground (see Figure 2.5.16).

Figure 2.5.16 Scissor Lift

Bucket Truck

A bucket truck is similar to a manlift. However, a bucket truck can be driven on a highway, and the inspector controls bucket movement (see Figure 2.5.17). As with the manlift, a bucket truck needs to be used on fairly level terrain. Bucket trucks have a number of different features and variations:

- Lift capability - varies 25 to 50 feet.
- Rotating turret - turning range (i.e., the rotational capability of the turret) varies with each vehicle.
- Telescoping boom - some booms may be capable of extending and retracting, providing a greater flexibility to reach an area from a given truck location.
- Multiple booms - some bucket trucks have more than one boom, and provide reach up to 50 feet.
- Outriggers - bucket trucks that offer extended reach and turning range have outriggers or supports that are lowered from the chassis of the vehicle to help maintain stability.
- Truck movement - some vehicles offer stable operations without outriggers and can move along the bridge during inspection activities. Vehicles that require outriggers for stable operations cannot be moved during the inspection unless the outriggers have wheels.

Figure 2.5.17 Bucket Truck

A track-mounted man-lift provides access to areas with rough terrain that a conventional bucket truck would not be able to navigate (see Figures 2.5.18 and 2.5.19). By utilizing rubber tracks, track-mounted man-lifts can be operated in water, climb 35 degree slopes, traverse 25 degree side slopes, and navigate wet and muddy terrain.

Figure 2.5.18 Track-mounted Man-lift in a Stream

Figure 2.5.19 Track-mounted Man-lift on a Slope

Under Bridge Inspection Vehicle

An under bridge inspection vehicle is a specialized bucket truck with an articulated boom designed to reach under the superstructure while parked on the bridge deck. Usually the third boom has the capacity for extending and retracting, allowing for greater reach under a structure. Some of the larger under bridge inspection vehicles have four booms, allowing an even greater reach (see Figure 2.5.20).

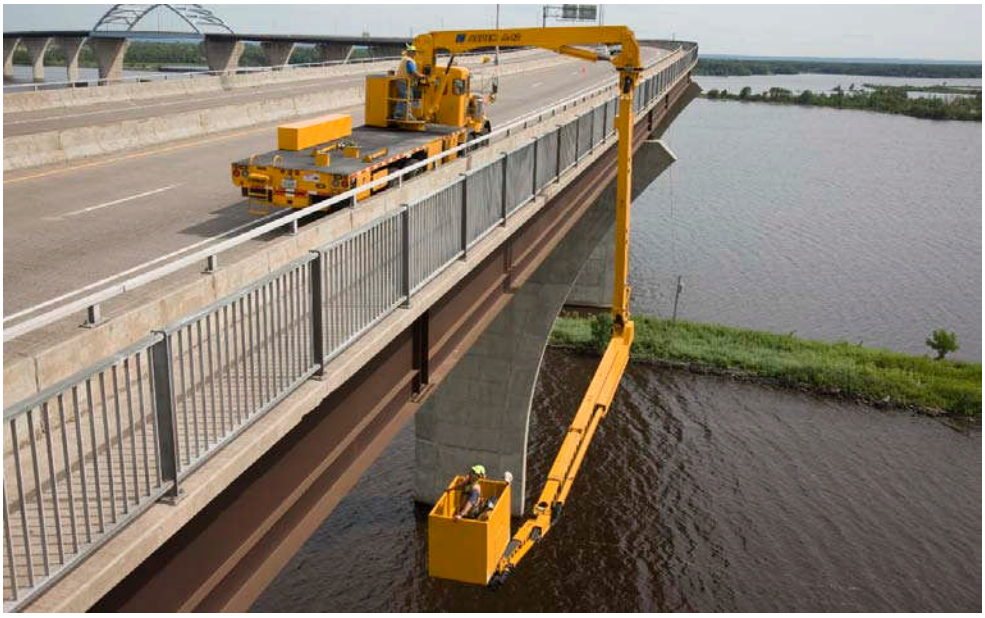

Figure 2.5.20 Under Bridge Inspection Vehicle with Bucket

Variations and options available on different models include:

- Capacity - Some under bridge inspection vehicles have a two or three person bucket on the end of the third boom. Other models are equipped with a multiple-person platform on the third boom with a ladder on the second boom. Still other models may have the capability of interchanging a bucket and a platform in the shop.
- Platform – The platform is lowered by an articulated boom and can then telescope out to provide inspection access to a wide range of the superstructure and substructure. The inspector is now free to walk from beam to beam without having to reposition the platform (see Figure 2.5.21). This combination allows for an efficient and thorough inspection.
- Telescoping second boom - Some under bridge inspection vehicle models have a second boom that can extend and contract, providing greater movement in the vertical direction.
- Articulated third (or fourth) boom - Some under bridge inspection vehicle models have a small third or fourth boom that allows for greater vertical movement under the structure. This option is particularly useful on bridges with deep superstructure members.

Figure 2.5.21 Under Bridge Inspection Vehicle with Platform

2.5.4 Method of Access and Cost Efficiency

In most cases, even the most sluggish lift device will be quicker than using a ladder, rigging or free climbing to inspect a structure. The time saved, however, needs to offset the higher costs associated with obtaining and operating an access vehicle.

In assessing the time-saving effectiveness of an access vehicle, the following questions need to be answered:

- Can the bridge be safely inspected by other reasonable methods?
- What types of access vehicle or access equipment are available?
- How much of the bridge can be inspected using the access vehicle?
- How much of the bridge can be inspected from one setup of the access vehicle?
- How much time does it take to inspect at each setup?
- How much time does it take to move from one setup to the next?
- Does the vehicle require an independent operator or driver other than the inspector?
- Will the use of the access vehicle require special traffic control?
- Can the bridge carry the weight of an inspection vehicle?
- What are the associated costs of using a bridge inspection access vehicle?

The inspection time, safety and vehicle costs can then be compared to standard access equipment.

2.5.5 Safety Considerations

Safety is the primary concern on any job site, not only of the workers but of the public as well. The equipment and vehicles being used also have safety considerations.

Access Equipment

Before the bridge inspection begins, an equipment inspection is performed. As a minimum, inspect access equipment as per the manufacture's guidelines. Using faulty equipment can lead to serious accidents and even death. Check the equipment and verify that it is in good working condition with no defects or problems. If rigging or scaffolding is being used, check to ensure that it was installed properly and that the cables and planks are secured tightly. Use OSHA-approved safety harnesses with shock absorbing lanyards when using access equipment.

Access Vehicles

If the inspector is not familiar with the inspection vehicle being used, then take the time required to become accustomed to its operation. In some cases, formal operator training may be necessary or required. When operating any inspection vehicle, always be aware of any overhead power lines or other hazards that may exist. It is also important to be aware of any restrictions on the vehicle, such as weight limits for the bucket, support surface slope limits, and reach restrictions. Always be alert to your location. Do not extend the boom out into unsafe areas such as unprotected traffic lanes or near electrical lines. Use OSHA-approved safety harnesses with shock absorbing lanyards when using access vehicles.